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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04Q 9/00, H04L 12/423 — A1

(11) International Publication Number: **WO 98/04095**

(43) International Publication Date: 29 January 1998 (29.01.98)

(21) International Application Number: PCT/AU97/00461

(22) International Filing Date: 22 July 1997 (22.07.97)

(30) Priority Data:
PO 1172 22 July 1996 (22.07.96) AU

(71) Applicant *(for all designated States except US)*: NILSEN INDUSTRIAL ELECTRONICS PTY. LTD. [AU/AU]; 162 Dougharty Road, Heidelberg West, VIC 3081 (AU).

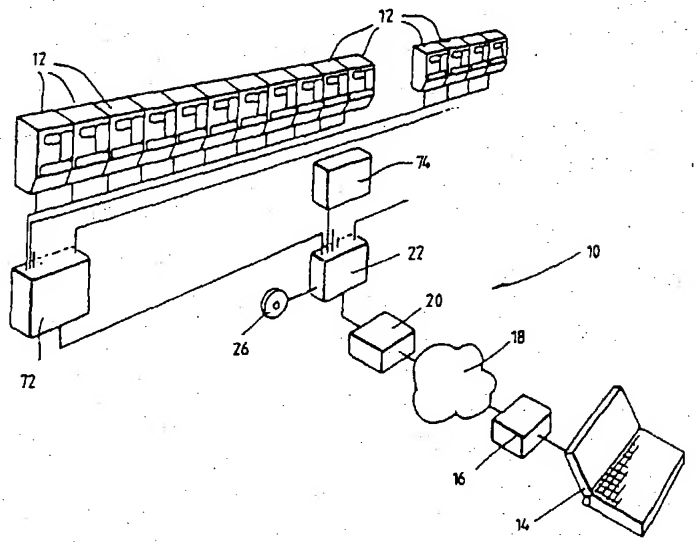
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: SCHÜRMANN, Richard [AU/AU]; 254 Research Road, Warrandyte, VIC 3113 (AU). WONG, Tak, Kim [AU/AU]; 17 Cerutty Way, Wantirna South, VIC 3152 (AU). WATTERS, Andrew, James [AU/AU]; 493 Glenferrie Road, Hawthorn, VIC 3122 (AU).

(74) Agents: MACAULEY, Colin, Douglas et al.; Callinan Lawrie, 278 High Street, Kew, VIC 3101 (AU).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: NETWORKING SYSTEM



(57) Abstract

A networking system (1) including a main server (22) connected bi-directionally to a programmable electronic device (14). The main server (22) having an input port (34) and output port (36) both connected to the programmable electronic device (14). The main server (22) has a plurality of communication ports (48-70) each connected to a loop containing at least one electronic device (12) or additional server (72, 74). Each of the plurality of communication ports (48-70) being combined to be connected to both input port (34) and output port (36) of main server (22). Where preferably the programmable electronic device is a computer, and the electronic device is a data meter device. The data meter devices are individually addressable. The loop includes isolators in event of a fault and the server parts include distortion cancellation and echo blanking circuitry.

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NETWORKING SYSTEM

TECHNICAL FIELD

The present invention relates to a networking system and relates particularly, although not exclusively, to a networking system for remote reading of electronic devices.

PRIOR ART

The connection together of electronic devices to form local area networks for data transfer is well known and there are many conventions describing the physical and electrical characteristics of devices, connections and message structures. Examples of such networks may be seen in the computing industry where standards such as 20mA Current Loop, RS232 and RS485, etc are applied. A characteristic of most of these conventions is that when devices are attached together, the transmittal of messages from one device to another requires that at the point of attachment of each end-device to the communications means, or somewhere incorporated in the communications means, there are control means to correctly address communications and to prevent corruption of transmissions arising from message collisions or contention between simultaneous messages.

For example where RS232 networks are used to connect several devices to a single point, a multiplexer or similar message routing device is used which requires information to be entered giving an address for each end device, and messages must be correctly addressed in order to be transmitted. From the multiplexer, only one device is usually attached to each connecting line ie the network is characteristically radial.

Voltage systems such as RS422 can operate with several devices attached to a single line in a parallel connection, but there is a limit on the length and physical configuration of the line and the number of connected devices governed by parameters such as

line impedance characteristics. This limit is partly dependent on the data transmission rate. Also if the line is broken, or should a short circuit occur between the conductors constituting the line, transmission is prevented between any of the devices. Current Loop systems using a regulated current source may be used to connect devices in a series loop. There is also a limit on the number of devices imposed by the voltage drop occurring in each device and the maximum or allowable voltage available on the loop. This method using a 20 mA current is well known. If the loop is broken, or the current short-circuited, the loop will fail. In both cases described above, where multiple devices are connected directly together (RS485/422 - voltage in parallel, or 20 mA - current in series) the devices all receive a transmitted message simultaneously. Each device must be designed and the messages addressed and structured, so that only one device or no devices in the group so-connected is allowed to provide a return message, otherwise contention will occur and responding transmissions are likely to mutually corrupt.

Limitations on the scale of such systems are imposed by line and device characteristics (eg. impedance of a voltage system or a total voltage drop on a current system). Where it is required to connect large numbers of devices to receive single transmissions from, and to provide a response pathway back to a single point, these constraints require that means be employed to scale up the capability of a single loop (or bus) to provide an effective multiplicity of parallel paths, each receiving the "broadcast" transmission but providing for an uncontested response from a single device on one of the parallel paths. Also, because there is always a significant chance of there being a fault in any device or connection line, it is also very desirable that an interconnected system remain able to be used when parts of the

system contain faults such as open circuits or short circuits, save for those portions containing the fault.

Electricity energy meters and similar metering or data acquisition and control equipment are examples of end-point devices that may be connected to communications links employing RS232, RS485 or 20 mA Current Loop systems among others. The most common reason for such connection is to permit the meter or other device to be connected to a data processing means such as a computer to allow programs or instructions to be downloaded to each meter, and to allow information such as metered data or equipment status to be obtained. Communication may take place directly between the two devices (with a suitable cable connector to physical ports) or include optical interfaces, telephone modems and telephone links, radio devices and radio links, optical fibre data transmission links, etc or some of these in series between the devices. These implementations are all well known. Normally, it is necessary to create the communication link to the required end-device and operate in a point-to-point manner. In the directly connected scenario first described, this is obvious; ie the devices are only connected one to the other. It is not essential in such a case that the devices have unique addresses. Where intermediate links such as telephone, radio or the like, are used, a means of addressing is essential. For telephone systems, the telephone modem (receiver) must be "known", and if more than one end-use device is connected to the same telephone point, each of them must have a known individual identifier (ie. device address). For radio systems, the radio receiving interface may have an address, but if it does not, or if there is more than one device connected to the one radio interface, each device also requires a unique device address. Where there is a large number of devices to be communicated from a single point, whether it be

directly (ie. a hand-held computer at an electrical or optical interface) or via a telephone or radio link, the means of ensuring that all devices may be addressed and any device from which a response is required may reply is required.

Satisfying the requirements of this application is the purpose of this invention, which describes means of operating current loop systems in parallel, and in cooperation so that the effect is the same as if the loop was unconstrained in size by the practical considerations normally applying to a single loop.

SUMMARY AND OBJECTS OF THE INVENTION

It is an object of the present invention to provide a networking system which alleviates the abovementioned problems.

A further object of the invention is to provide a networking system having a plurality of loops for end devices requiring no addressable multiplexers, hubs or routers.

In aspect of the invention there is provided a networking system including a main server adapted to be connected bi-directionally to a programmable electronic device, said main server including an input port and an output port both of which are adapted to be connected to said programmable electronic device, said main server further including a plurality of communication ports each of which is adapted to be connected to a loop containing at least one electronic device or additional server, each of said plurality of communication ports being combined to be connected to both said input port and said output port of said main server.

In a further aspect there is provided a non-wireless networking system for transparently and simultaneously transmitting at least a first message in half-duplex format electrical voltage or current binary signals entered at one point to a plurality of separate end points, and said networking system being capable

of transmitting a return message from any one of said end points to said one point of entry, whereby only one of said end points can transmit said return message at any one time and that said only one of said end points is the end point being addressed by said at least said first message.

Preferably said end points are connected in groups with each group including a plurality of said end points in a series loop. Preferably a plurality of said series loops are provided in parallel and said at least said first message is transmitted on all said loops simultaneously.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be clearly understood there shall now be described by way of a non-limitative example only a preferred construction of the invention incorporating the principal features of the present invention. The description is with reference to the accompanying illustrated drawings in which:

Fig. 1 is a perspective view of a networking system made in accordance with the invention;

Fig. 2 is a circuit block diagram of the networking system shown in Fig. 1;

Fig. 3 is a partial block diagram of the networking system shown in Fig. 1;

Fig. 4 is an enlarged partial circuit block diagram of a part of the networking system shown in Fig. 2 in error mode; and

Fig. 5 is a similar view to that of Fig. 4 in normal operation mode.

DETAILED DESCRIPTION OF THE DRAWINGS

In the drawings there is shown a networking system 10 that will be described with reference to its use in relation to electricity meters. The invention is not limited to that application as will be obvious to the man skilled in the art. In this embodiment

a plurality of end devices in the form of "smart" electricity meters 12 are located in various locations in buildings or elsewhere. Meters 12 may be of the type shown in US Patent No. 4,978,911, also known as the Nilsen EMS2600 or similar meter. Such meters may have a 20mA Current Loop or RS232 interface for connection to a network or directly coupled to reading device (not shown), when required . Each meter will have a unique ID and can be interrogated through the network or reading device to allow a download of power usage parameters and/or have information uploaded to it.

In the illustrated embodiment the meters are interrogated by a computer 14 in a variety of ways. Fig. 1 shows computer 14 being connected to a modem 16 which is connected to a telephone network 18. Computer 14 is remote from the networking system 10 and is connected by a modem 20 at the networking system site. Modem 20 is coupled to the network main server 22 via an interface (RS232 or 20 mA Current Loop) 24 which will be well known to a man skilled in the art. Fig. 3 shows that computer 14 can also be used locally by communicating through interface 24 or by an optical interface port 26. A probe 28 can attached by cable 30 to an appropriate peripheral card inserted in computer 14. Computer 14 may be replaced by a proprietary programmable hand held device (not shown) as necessary. Such a hand held device could be readily carried by a human meter reader. Main server 22 has a main I/O path 32 comprising input port 34 and output port 36. An input signal in the form of a sequence of marks and spaces with approximately equal duration, in binary code, is conditioned and impressed on input port 34 from interface 24 or optical interface 26. In the case of RS232, this is in the form of voltage impulses on the "transmit" line. In the case of 20mA Current Loop, this is

in the form of a current of 10-20 mA as the quiescent condition, with a signal being "spaces" of near zero current. In the case of the optical port interface 26, the signal is a light pulse emitted by the optical port interface 26 where the "mark" is zero signal, and the "space" is a period where the emitted light is sustained for the prescribed time. In this embodiment, the binary data rate is normally 4800 baud, but this is not a requirement. The invention will operate at higher or lower data rates without requiring any intervention or configuration.

The signals 38,40 from interfaces 24,26 are passed through a contention resolving circuit 42 which locks out access to the interface 24 if the optical port interface 26 is in use, or locks out the optical port interface 26 if the interface 24 is in use. There is preferably a 10 second lock-out period after the last data bit in the downstream direction, and also a lock-out process which prevents downstream transmission on the alternative port if an upstream transmission is in process. Signal 44 from contention resolver 42 is processed by a "telegraph distortion and echo blanking" module 46. Telegraph distortion may arise as a result of characteristics of end-point devices 12, upstream or downstream, where the "on" and "off" transitions in signalling do not occur at the same speed. Telegraph distortion increases the likelihood of signalling errors. The telegraph distortion function can be adjusted also to reduce distortion arising in other devices. The Echo Blanking function is required in a half duplex scheme to the invention to allow bi-directional signalling. In a 2 wire half-duplex circuit, a signal appears in the output and input circuits simultaneously. This is not a problem in a two element system where each component is solely either the sender or the receiver, in which case they are both unambiguously sending or receiving. When a third element also being bi-directional, such as the main

server 22 being inserted, the appearance of the same signal at both input and output of this intermediate element appears as contention. The "echo-blanking" function suppresses feedback from the output side from being sensed as an "incoming" signal, regardless of direction of the message. This priority is established by the direction of the signal.

Signal 34 from module 46 is passed to main server 22. Signal 34 is reproduced in parallel at all output ports 48-70 as a modulation of the 20mA Current generated in each loop. Main server 22 can have output ports 48-70 arranged to connect in a series loop one or more meters 12 which can be one per port, or connected in series up to 12 per port. Server 22 can, in this embodiment, support up to 12 units (being electricity meters 12 with 20mA current loop facilities) per loop and up to 12 loops. Each server may operate 144 meters 12 as shown in Fig. 3. If output ports 48-70 are cascaded to further servers 72,74, similar to main server 22, then it is possible to run cascaded multiples of 144, up to 144 to the third power as shown in Fig.2. The numbers of output ports can be varied depending on requirements.

Each of the ports 48-70 are connected to a respective line 78 of a "break detect, alarm and isolate circuit" module 76. The output signals 80 from module 76 are processed by combination module 82 which produces a signal on output port 36. The signal from output port 36 is processed by a further "telegraph distortion and echo blanking" module 84, similar to module 46 and the processed signal returned to the selected interface 24,26 for interrogation by computer 14.

In use, upstream transmission can only be initiated by an end-device 12 following an instruction from the computer application residing at computer 14. The instruction must be addressed to a specific device, say 12A, using a unique address,

and must also stipulate the nature of the response. A message from computer 14 is broadcast across the whole networking system 10 through all servers 22,72,74 to all devices 12 including 12A. Following the message broadcast further downstream transmission is halted for a programmable predetermined period to allow the addressed device 12A to respond, as only one device 12 can be addressed with an instruction requiring a response at any one time. The addressed device 12A will respond with a return message in the same format as the downstream message to the server 72 on its own current loop 86. The upstream transmission is passed through "break detect, alarm and isolate circuit" module 76A which will also isolate server 72 from unintended high voltages such as may be produced by lightning or vandalised control lines, and open circuits such as may arise from equipment fault or broken wires. Other loops are also isolated from such faults. All upstream transmissions are routed to combination module 82A to provide a single upstream line which is returned to main server 22 and finally to computer 14 where the transaction was initiated.

Fig. 4 shows a normally operating port 48A. When current is flowing normally, such as in the quiescent (no signal state), or in a normal mark/space sequence, "break-detect" functions are "off". When the 20mA current falls to zero, because of an open circuit in the loop 86 (Fig. 5), or a transmission fault in device 12A which causes extended spaces, the break detect function activates, causing the faulty loop 86 to be shunted out of circuit (producing a "mark" signal ie. normal quiescent state upstream, and eliminating interference with other loops). An indicating fault lamp 88 is also set showing which loop 86 is isolated. In the downstream port circuit of each server 22,72,74 both signal conductors comprising the 20mA loop may be protected by fuses

(not shown), and may be also linked to earth by semi conductor devices (not shown) normally open circuit, but which will conduct if line voltage is mains voltage or higher, causing over-current to be fused to earth.

In practice, signals are capable of being transmitted over distances greater than 100 meters. Signalling data rate can be any speed but speeds are preferably between 1 and 20,000 baud. The invention provides a simple networking system which requires no addressing for the servers. Computer 14 does not need to know where a particular meter 12 resides to address it. Any defective loop can be readily isolated and technicians can be readily despatched to locate the problem.

Whilst there has been described in the foregoing description preferred constructions of a system incorporating certain features of the present invention, it will be understood by those skilled in the technology concerned that many variations or modifications and details of design or construction may be made without departing from the essential features of the present invention.

CLAIMS

1. A networking system including a main server adapted to be connected bi-directionally to a programmable electronic device, said main server including an input port and an output port both of which are adapted to be connected to said programmable electronic device, said main server further including a plurality of communication ports each of which is adapted to be connected to a loop containing at least one electronic device or additional server, each of said plurality of communication ports being combined to be connected to both said input port and said output port of said main server.

2. The networking system of claim 1, wherein each additional server includes a plurality of further communication ports each of which is adapted to be connected to a further loop containing at least one further electronic device or an identical server, each of said plurality of further communication ports being combined to be connected to both an input port and an output port of the respective additional server.

3. The networking system of claim 1 or 2, wherein each electronic device has a unique address whereby said programmable electronic device can broadcast a message to all of said electronic devices for response by a predetermined one of said electronic devices but only said predetermined one of said electronic devices can respond to said message.

4. The networking system of claim 3, wherein each loop includes an isolation means to isolate any loop which reports a fault.

5. The networking system of any one of the preceding claims, wherein said programmable electronic device is a computer.

6. The networking system of any one of the preceding claims, wherein said electronic devices are data metering or acquisition devices.

7. The networking system of any one of the preceding claims, wherein said programmable electronic device, in use, can transparently and simultaneously transmit a first message in half-duplex format electrical voltage or current binary signals to said input port of said main server to said plurality of communication ports to all said electronic devices, said first message requiring a response from only one of said electronic devices, said one of said electronic devices being capable of transmitting a return message on receiving said first message, whereby only said one of electronic devices can transmit said return message at any one time.

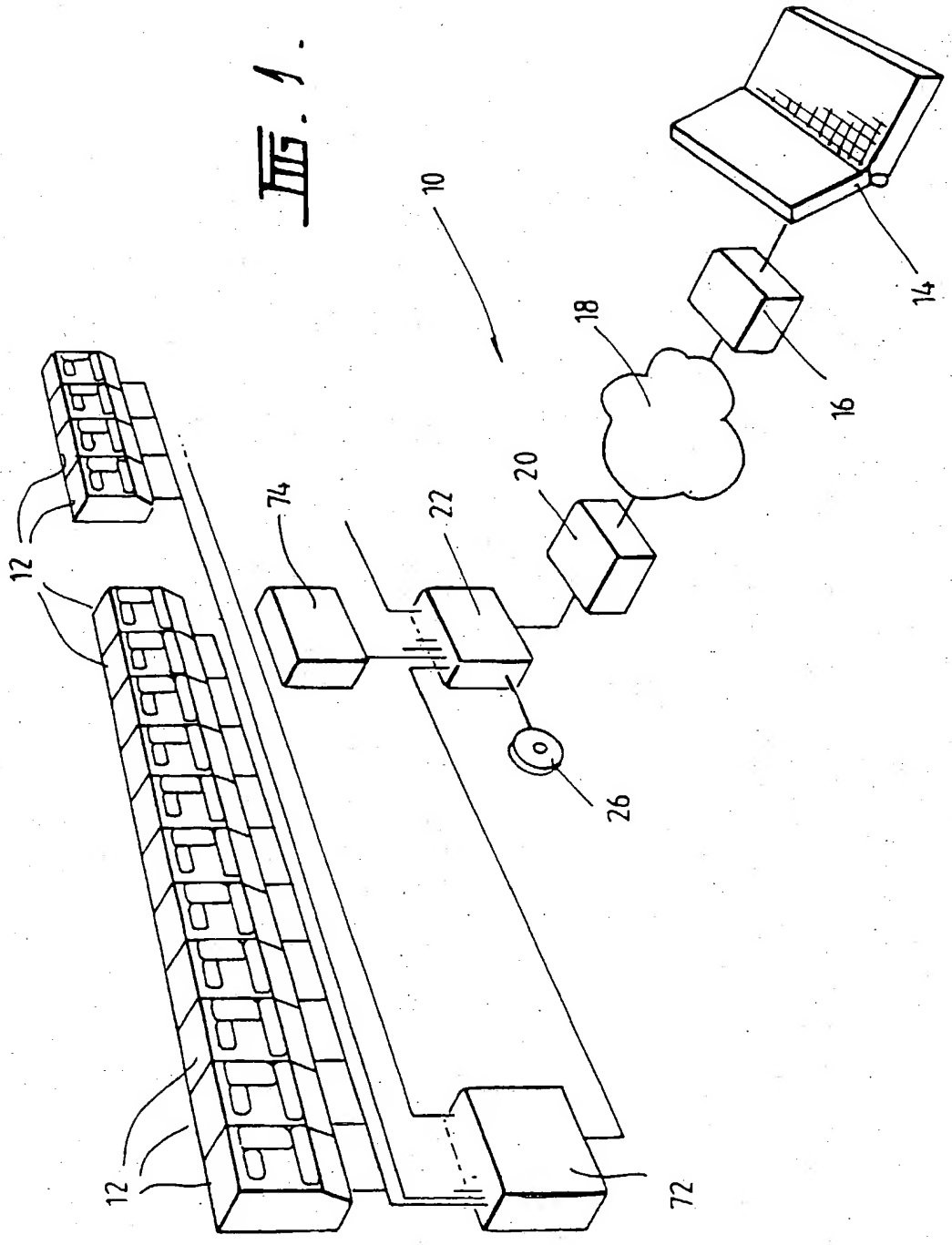
8. The networking system of any one of the preceding claims, wherein each of said input and output ports of said main server are coupled to respective telegraph distortion cancellation and echo blanking circuitry.

9. A non-wireless networking system for transparently and simultaneously transmitting at least a first message in half-duplex format electrical voltage or current binary signals entered at one point to a plurality of separate end points, and said networking system being capable of transmitting a return message from any one of said end points to said one point of entry, whereby only one of said end points can transmit said return message at any one time and that said only one of said end points is the end point being addressed by said at least said first message.

10. The non-wireless networking system of claim 9, wherein said end points are connected in groups with each group including a plurality of said end points in a series loop.

11. The non-wireless networking system of claim 10, wherein a plurality of said series loops are provided in parallel and said at least said first message is transmitted on all said loops simultaneously.

FIG. 1.



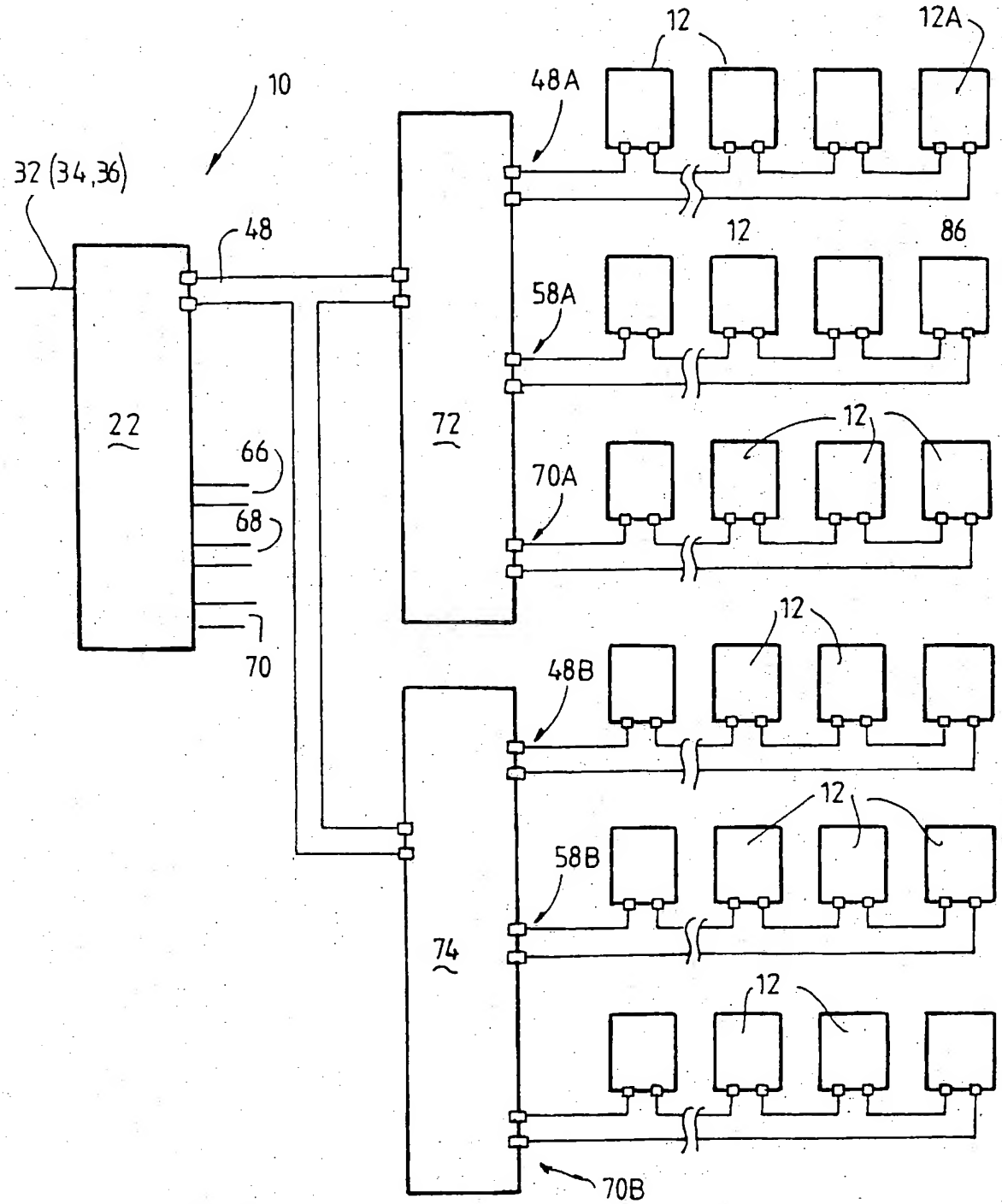


FIG. 2.

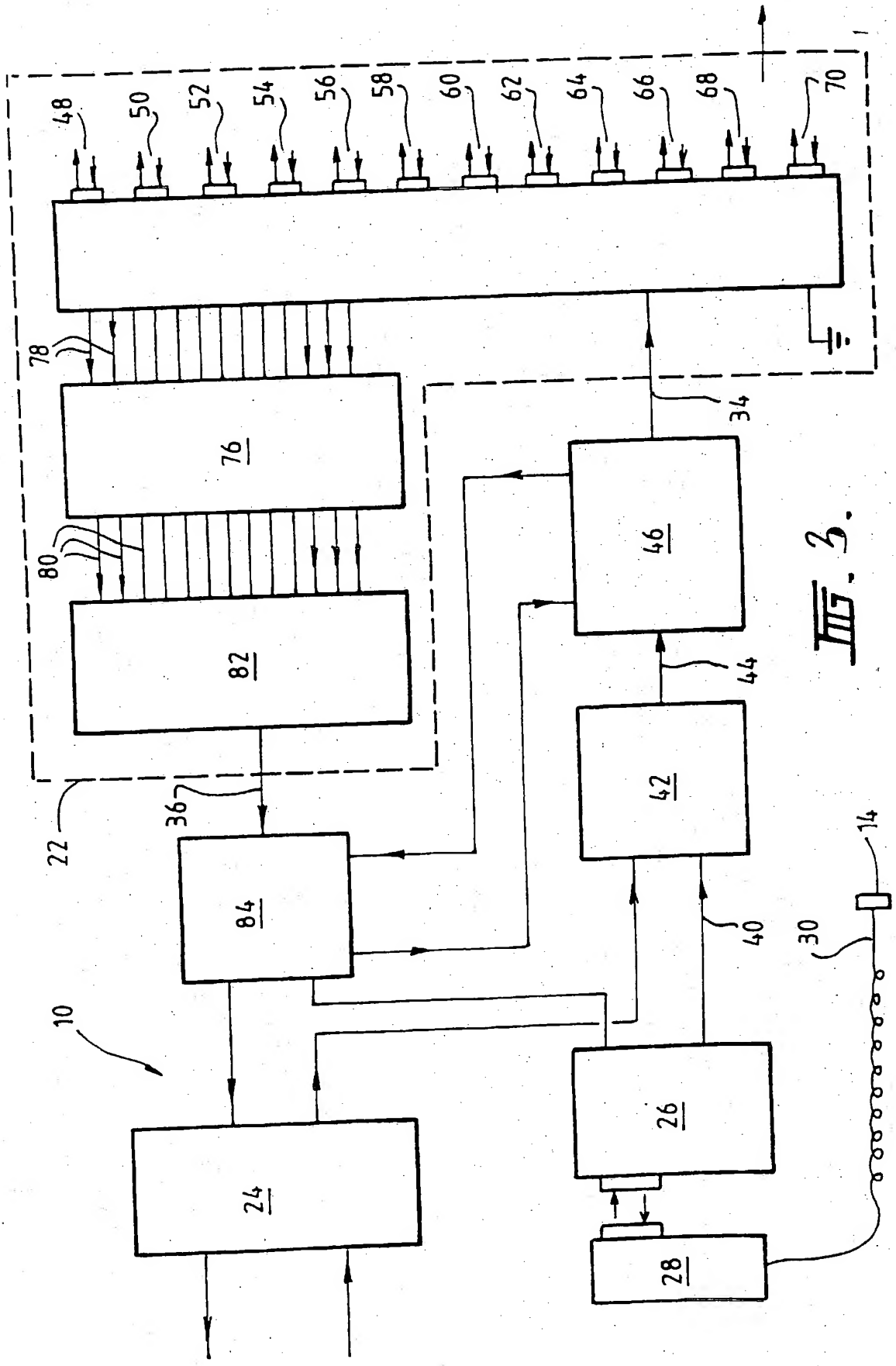

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Fig. 2.

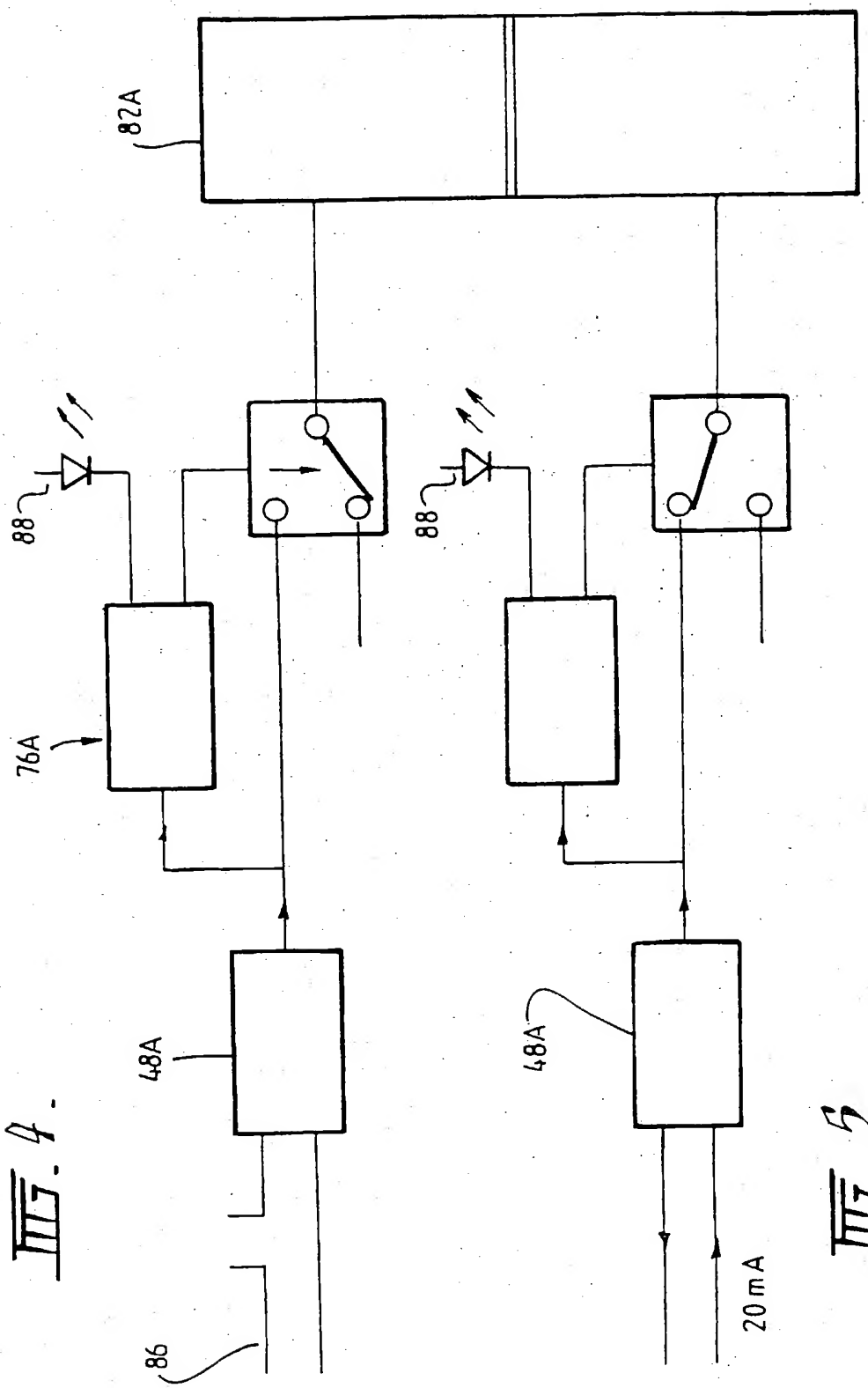

Fig. 4.

Fig. 5.

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00461

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: H04Q 9/00 H04L 12/423

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: H04Q 9/00, H04L 12/423

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5509054 A (GARLAND) 16 April 1996 Whole document	1-8
X	US 5252967 A (BRENNAN et al) 12 October 1993 Whole document	1-8
X	US 5243644 A (GARLAND et al) 7 September 1993 Whole document	1-8

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 October 1997	29 OCT 1997
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929	Authorized officer *R Stopford* Telephone No.: (02) 6283 2177

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00461

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5128988 A (COWELL et al) 7 July 1992 Whole document	1-8
X	US 4833618 A (VERMA ET AL) 23 May 1989 Whole document	1-8
X	US 3962545 A (ABE) 8 June 1976 Whole document	1-8
X	GB 2262682 A (THEMES WATER UTILITIES LIMITED) 26 June 1993 Whole document	1-8
X	WO 92/12590 A1 (SASKTEL) 23 July 1992 Whole document	1-8
X	WO 89/08959 A1 (TELEMETRY RESEARCH II, INC.) 21 September 1989 Whole document	1-8

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 97/00461

Box I **Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

Continued,

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-8

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

Continuation of Box No:II

The International Application does not comply with the requirements if unity of invention because it does not related to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are two inventions:

Claim 1 is directed to a networking system including a main server with input, output ports connected to a programmable logic device, and also the main server includes a plurality of communication ports connected to a loop with 1+ electronic devices or additional servers wherein each of the plurality of communication ports are combined to be connected to both the input and output ports.

It is considered that the provision of a main server including input, output ports and a plurality of communications ports connected to a loop containing 1 + electronic devices or additional servers, where also the plurality of communication ports is the first special technical feature.

This first special technical feature can similarly be seen in claims 2-8 which are dependent on claim 1.

Claim 9 is directed to a non wireless networking system which transmits a message in a half duplex format from one entry point to a plurality of separate end points, a return message is made from the fend point tot the entry point, but only end point can transmit the return massage at any one time, this end point being the one that was addressed by the message.

It is considered that the transmission of a message from an entry point to plurality of end points, where only the end point that is addressed may respond with a return message is the second special technical feature.

This second special technical feature can similarly be seen in claims 10-11 which are dependent on claim 9

Since the above mentioned groups of claims do not share any of the special technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International Application No.
PCT/AU 97/00461

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5509054	AU	65165/94	BR	9406524	CA	2162111
		CN	1122638	CZ	9502952	EP	698325
		FI	955435	HU	73369	NO	954459
		NZ	263905	PL	311631	US	5394461
		WO	9427396				
US	5252967	AU	76475/91	AU	64664/94	BR	9102136
		CS	9101569	EP	463893	HU	63523
		JP	5095585	NZ	238245	PL	290406
		US	5155481	US	5243338		
US	5243644	AU	81759/91	CA	2043598	CA	2095668
		EP	474407	JP	4246961	JP	9181833
		US	5189694				
US	5128988	AU	74727/91	NZ	237490	WO	9115074
US	4833618						
US	3962545	JP	50112067	JP	50112067		
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WO	9212590	AU	90992/91	CA	2099489	GB	2266642
		NZ	241221	US	5548633		
WO	8908959	AU	33519/89				

END OF ANNEX